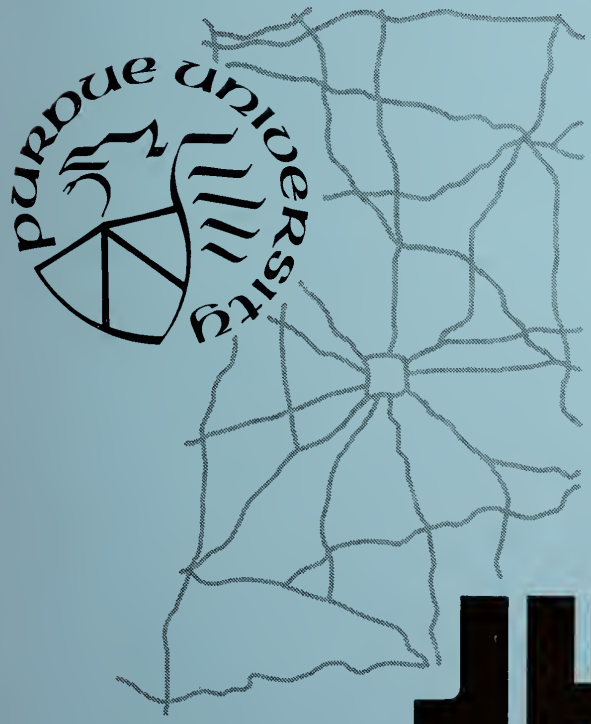
IMPROVEMENT OF KENTUCKY BLUEGRASS THROUGH SELECTION AND BREEDING

JULY 1972 — NUMBER 25



BY

W. H. DANIEL

JHRP

JOINT HIGHWAY RESEARCH PROJECT

PURDUE UNIVERSITY AND
INDIANA STATE HIGHWAY COMMISSION

Final Report

IMPROVEMENT OF KENTUCKY BLUEGRASS THROUGH SELECTION AND BREEDING

TO: J. F. McLaughlin, Director
Joint Highway Research Project

July 26, 1972

Project: C-36-48C

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 9-5-3

The attached Final Report "Improvement of Kentucky Bluegrass Through Selection and Breeding" is submitted as fulfillment of the objectives of Part I of the HPR Part II Research Study "Research in Roadside Development and Maintenance". The Report has been authored by the principal investigator, Dr. William H. Daniel.

The Study has progressed to the point where thirteen (13) selections of bluegrass have been made. The final selection of the fewer types to be finally selected for seed increase and further testing is planned as the initial portion of a new HPR Research Study titled "Superior Bluegrasses for Roadside Turf".

This Report is submitted for acceptance. It will also be submitted to the ISHC and FHWA for review, comment and acceptance as fulfillment of the objectives of Part I of the referenced HPR Study.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
Associate Director

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Final Report

IMPROVEMENT OF KENTUCKY BLUEGRASS THROUGH SELECTION AND BREEDING

by

W. H. Daniel
Professor

Department of Agronomy

Joint Highway Research Project
Project No.: C-36-48C
File No.: 9-5-3

Prepared as Part of an Investigation
Conducted by
Joint Highway Research Project
Engineering Experiment Station
Purdue University
In cooperation with the
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and the
U.S. Department of Transportation
Federal Highway Administration

Purdue University
West Lafayette, Indiana
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Introduction

The purpose of this project was to select Kentucky bluegrass varieties whose characteristics would meet the rigid requirements of roadside turf. Requirements considered most important include: increased rhizome spread - for quick establishment and long term maintenance of sloping areas; low growth characteristics to reduce mowing frequency and plant resistance to common turf disease.

The low growth habit is one of the most important characteristics. There are over 600 miles of Interstate Highway systems in Indiana, with approximately 18 acres per linear mile, giving a total of 11,000 acres which need to be mowed 4 times each year. At a mowing cost of $10.00 per acre, an estimated cost per year is $440,000. A 50% reduction in mowing frequency requirements would amount to annual savings of $220,000.

This project was undertaken with the knowledge that a superior turfgrass would need only out-perform combinations of Kentucky bluegrass, tall fescue, perennial and annual rye, and be propagated by seed.

Historically

It has been observed that through natural adaptation of species, bluegrass becomes the more dominant grass existing along roadsides in Indiana. Throughout the cool, humid region, its persistence illustrates its adaptability to this climate. The inability of available varieties to develop into an established turf has been the source of maintenance

problems throughout the many years of highway roadside development. In addition, the specifications for tall fescue, annual and perennial rye, and common Kentucky bluegrass for roadsides presents mowing and erosion problems which need solving.

For many years common Kentucky bluegrasses, either Midwestern, Northwestern, or foreign grown, have been used in roadside plantings. Improved varieties were gradually developed. In 1950, Merion, with leafspot resistance, but susceptible to rust, matforming, and requiring high fertility, was released. Since 1960, Newport, which produces heavy seed yields, has seen rapid increase in seed production, then a decreased demand. Delta bluegrass was selected in 1950. It has been increased slowly. It is much like common Kentucky, but with some extra seedling vigor. Park bluegrass from Minnesota was another release made about 1960. These grasses found their greatest acceptance as blends in bluegrass lawns. Other bluegrass varieties have found their way into the market since 1960. These have appeared only recently and include such varieties as: Fylking, Pennstar, Sydsport, Sodco, Nugget, Baron, Windsor, A-20, A-34. Others are in production and will be available in 1973.

Not one of these improved varieties was selected for roadside use, and no one grass had any special value for roadsides. Some require heavier fertilization, have yellow leaf color, fine leaves which fall over quickly, or produce excess, stemmy seedheads. Selections were not made for rapid establishment, ability to compete, low seedhead height,

and disease resistance, all of the characteristics of a good highway turf.

Purdue Bluegrass Research

A very diverse, sexual parent of Kentucky bluegrass, Poa pratensis, existing in the turf research program at Purdue since 1965, had provided over 100 different, variable seedlings. Among these were several very fine, dark-green types, which could serve well as a lawn grass. At the other extreme, however, were several very coarse, wide-spreading, vigorous seedlings with many characteristics perferred for highway use. These latter grasses have been the basis for selection of improved bluegrasses, demonstrating low growth, abundant and vigorous rhizome and tillering, and disease resistance.

Intensive activity in selecting and propagating preferred types was started in 1965 by T. P. Riordan and Dr. W. H. Daniel as a highway research roadside project. Selections were put out as space plantings every year since 1965. These served as the basis for the screening of over 12,000 individual bluegrass plants for characteristics that would provide a superior roadside bluegrass. Data from the 1965, 1966, and 1967 screening program is included in Progress Report, "Research on Roadside Development and Maintenance, Part I. Bluegrass Research", by Daniel, W. H., and T. P. Riordan, dated 1968.

Throughout 1969 and into 1972, further research applicable to roadside bluegrass development was carried out. Investigations were made into the chromosome numbers of selected bluegrasses. The objective was to determine whether the number of chromosomes in a bluegrass plant was an indicator of mode of reproduction. The purpose of this objective was to seek a method that would permit more efficient selection techniques based on the assumption that low chromosome numbers would be associated with apomictic reproduction. Apomictic reproduction (non-sexual) of bluegrass varieties produces pregeny that remain true to type. Thus, if a superior plant is found it may remain superior through apomixis. Results showed that when the chromosome number of selections was compared to mode of reproduction there was little apparent relationship between determination of chromosome numbers and mode of reproduction. Therefore, the efficiency of selection to be obtained from identification of chromosome number was not a valid criteria. Individual cell counts ranged from 37 to 71, with the mean for selections ranging from 40 to 68.

The field research completed in 1968, 1969, and 1970 is reported in an attached Appendix "Selection of Poa pratensis L., (Kentucky bluegrass)" by T. P. Riordan. The data in this report as well as the earlier Progress Report was based on the evaluation of over 12,000 individual Kentucky bluegrass seedlings which were rated and measured with the goal of selection of types adaptable to roadside utilization.

All plants were rated for rhizome spread - the most important single desired feature - and mature leaf height

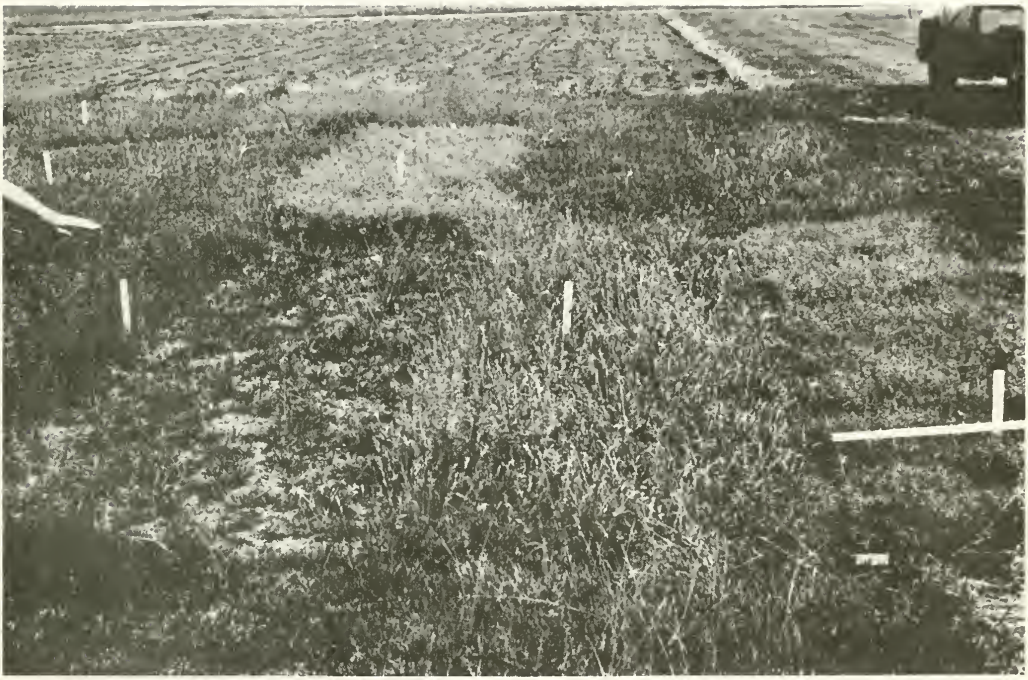

Figure 1. Variable Seedhead Height and Coloring of Second Year on Some Bluegrass Selections Grown at Lower Nitrogen Levels, Agronomy Farm, 10B3, 1971.

was measured to classify for lower growing types. Other ratings and measurements included in experiment 1 were: rust resistance, leaf color, winter survival, and panicle characteristics. In experiment 2, leaf color and panicle characteristics; and in experiment 3, rust resistance, leaf color, seed germination and seedling characteristics were recorded.

Superior bluegrasses with low growth and vigorous spread were planted on State Road 38 and Interstate 65 in fall of 1970. Also, the evaluation of new progeny as they developed continued in the breeder field space plantings. Roadside plantings were made as sod, and for some selections as seed. Bluegrasses included in this first roadside planting are included in Table 1.

Table 1. Selections (from 12,000 measured) used in first roadside planting in median of I-65 at Hy. 38 in fall of 1970.

From 10B1	As Plant	From 10B2	As Plant	From 10B3	As Plant
		as sod transfer			
65W	16H	A3		A4	10B1.1-10-1
	16B36	A20		A5	10B1.5-19-1
	Sydsport			A6	10B1.5-19-4
	16B1	A29		A9	
54E		B7		C7	
34W	16BB56	B29		C9	ATHENS 69-1
NW1		C21		C16	16F
2		C28		D18	C6 of 10A2
3	16B4.15-17	E27			
4	POA-D				
5					
		as seed			
NW2		A3		A4	
3		A20		A5	
4		A22		A6	
5		B7		A9	
		C21		B12	
		D20		C7	
		E27		C9	
				C16	5-9-2
				D2	
				D18	

Figure 2. Sodding and Seeding Experiment Started In September, 1970 on Median of I-65 at Hy. 38. A Very Difficult Site - Photo May, 1971.

Ten superior varieties were selected from the original 31 in October, 1971. Selections were made on the basis of superior low growth, vigorous spread, under low nutrition, and disease resistance. Second year field observations were continued in 1972 to confirm original selections of superior varieties. By August of 1972 superior varieties numbered 13. The final selection from these 13 will be made in the spring-summer of 1973. Those varieties considered as superior highway grasses will then be harvested for seed production beginning in 1973. Part of this seed increase should then be used for expanded experimentation in larger plots at more extensive locations on highway roadsides in Indiana. The remainder of harvested seed will be reserved as a basis for breeder seed and increase.

Twenty-five new bluegrasses were planted in the greenhouse in September 1971. These grasses were selected from the field breeding program, and highway roadside plantings. They were rated for seed germination, seedling growth, and disease resistance throughout the winter and spring of 1971-1972. Those types showing superior characteristics were then transplanted in the field in summer of 1972. Seed was harvested and stored for future roadside testing.

Also, in September 1971, both experimental and improved commercial releases of bluegrasses, plus two varieties of improved perennial ryegrass, were planted in large area plots. These plots are located on east and on west facing slopes along Interstate 65, 1 mile south of State Road 28. Soils were analyzed and adequate fertility levels established.

Seed planted at 1 lb./1,000 sq.ft. due to limited seed quantity available. Performance data for these grasses is recorded in Table 2.

Table 2. Bluegrass performance data for 1971-72. East-west slope roadside plots.

West facing slope	Best 10% Plot		Total plot area	
	6/20	8/72*	6/20	8/72**
	% stand		% stand	
Nugget bluegrass	95	79	60	56
Baron bluegrass	90	56	30	41
Pennstar bluegrass	40	53	20	48
Fylking bluegrass	80	58	50	42
Sydsport bluegrass	60	54	20	45
Dosco bluegrass	90	58	75	44
Compas ryegrass	89	78	40	57
Compas rye & Sydsport	--	--	--	--
Compi rye + Sydsport	--	--	--	--
Compi rye alone	90	79	40	60

* Average of 5 ratings.
**Average of 8 ratings.

East facing slope		
Nugget variety	75	70*
Baron Variety	70	70
Pennstar variety	30	30
Fylking variety	30	40
Sydsport	10	20
Sodco variety	50	60
10.B3-B12. experimental	20	20
9A1-C4(f)	20	20
9A1-C7	50	30
10B3-A11	50	30
10B2-B16	30	40
9A1-C6	20	30
9A1-C4	20	20
State highway mix	25	35
Sodco & Compas rye	25	45

*Average of 3 ratings.

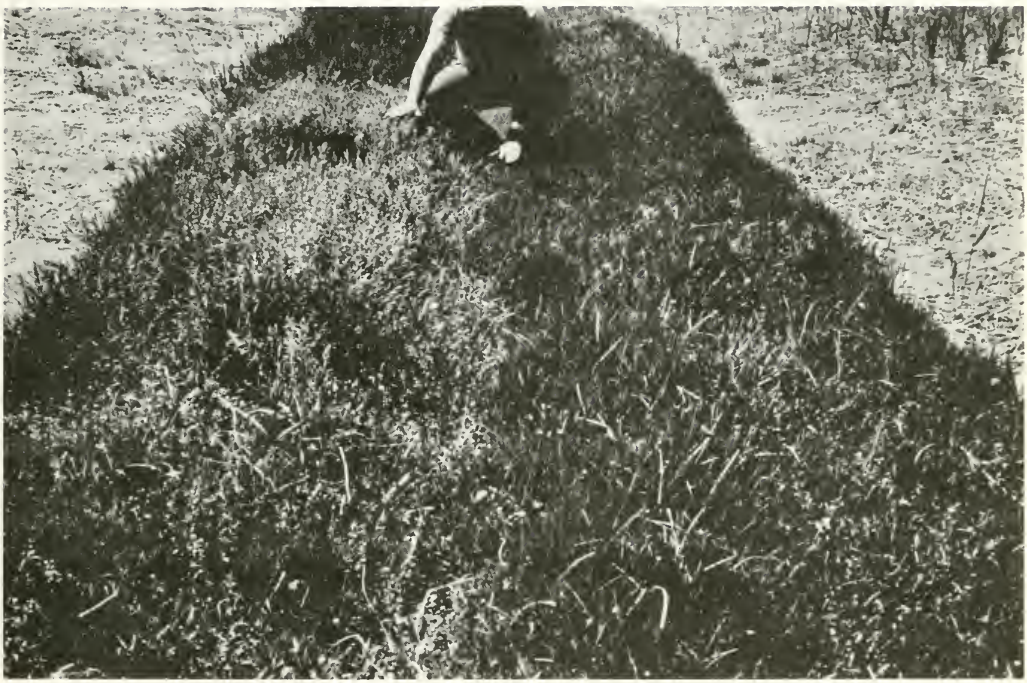

Figure 3. Variations in Seedhead Height of Sodded Portion of Median of I-65 at Hy. 38 Experiment. Height was 14" down to 6" in Selections.

Figure 4. Experiment on East Facing Slope of I-65 South of Hy. 28 Showing Highway Mix in Foreground, Ryegrass Strip Beyond Person, and Experimentation Bluegrasses in Background.

Future Plans

The above grasses planted at the Agronomy Farm as well as those planted at State Road 38 and Interstate 65, continue under observation and selection for superior observations with continuance through 1972 and 1973. Those grasses finally selected in 1973 should be planted for seed increase in September 1973. This seed increase should then be used to plant larger plots at highway roadside locations throughout Indiana. Seed increase should also continue so that adequate breeders seed will be available for contract seed production following final selection of superior varieties.

Listed below are those bluegrass types showing best performance in highway test plots by August, 1972. Out of these selections will come the bluegrasses to be recommended for seed increase and expanded testing.

Bluegrass code, ID.

1. 10B2 - B7
2. 10B3 - A4
3. 10B2 - A3
4. 10B2 - E27
5. 10B3 - A5
6. Sydsport*
7. 10B3 - A6
8. 10B1 - No. 5
9. 10B3 - C-16
10. 10B1 - No. 2
11. 10B3 - A-9
12. 10B3 - C-7
13. 10B1 - No. 1

*Sydsport is a new variety from Sweden, used because of its superior performance in turf trials at Purdue and in Europe.

Summary

This report includes an introduction to the existing highway problems and costs, as well as proposed solutions. The development of improved-adapted bluegrasses, which would contribute to more uniform turf, lower plant height, thus less mowing frequency required, would provide a solution to highway maintenance problems, and offer a reduction in maintenance costs.

A Progress Report, "Improvement of Kentucky Bluegrass Through Breeding and Selection", by W. H. Daniel and T. P. Riordan, was submitted September, 1968. This report identified the following characteristics required of a good roadside bluegrass:

1. Low panicle height
2. Low leaf height
3. Abundant and vigorous rhizome growth
4. Disease resistance
5. Good color

Initial screening in the above report selected bluegrass plants meeting these characteristics in one or more than one of the criteria. Thus, parent material was available for future testing.

The 1968 report was followed by a report titled "Selection of Poa pratensis L. (Kentucky bluegrass)" by T. P. Riordan, a copy of which is attached to this Final Report as Appendix A. This continues the reporting on the evaluation of superior bluegrass types, and results in a selection of 31 bluegrasses for incorporation into roadside tests.

This research also investigated the possibility of reducing time and expense involved in breeding and selecting superior uniform types through counting of chromosomes. The thesis proposed was that bluegrasses with low chromosome numbers would be apomictic, resulting in uniform reproduction. Seedlings would remain true to the parent throughout continued seed production. The research concluded that there was little basis to support this proposal. Low chromosome numbers did not serve as a key to selecting uniform apomictic varieties.

Finally, this Final Report reviews selections planted on highway roadsides and their performance and reports a selection of thirteen (13) superior types that will be further evaluated as the initial portion of a new research project in FY 73. Final selections of the bluegrasses to be recommended for seed increase and expanded testing are planned for the spring-summer of 1973 as part of that project.

APPENDIX A

SELECTION OF *POA PRATENSIS* L. (KENTUCKY BLUEGRASS)

by

Terrance Patrick Riordan

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ABSTRACT

Riordan, Terrance Patrick. Purdue University. Selection of *Poa Pratensis* L. (Kentucky Bluegrass).

Individual Kentucky bluegrass seedlings in 3 experimental space plantings were rated and measured with the goal selection of types adaptable to roadside utilization. All selections were rated and observed for uniformity in order that outstanding selections could be relegated either to future roadside tests because of uniformity of progeny (apomictic plants) or to future selection tests because of variability of progeny (sexual plants).

All plants were rated for rhizome spread and measured for leaf height. In each experimental planting there was an increase in the amount of rhizome spread and either no change or a slight decrease in leaf height. Other less important characteristics rated and measured were rust resistance; leaf color; winter survival; panicle height, quantity and maturity; seed germination; and seedling height and initial growth.

Simple correlation coefficients were calculated for all characters in each experiment. These coefficients indicated that there was a significant negative correlation between rhizome spread and leaf height, while panicle height was generally positively correlated to leaf height and negatively correlated to rhizome spread.

These results give promise that if leaf height is decreased it may be possible to have lower, more acceptable panicle heights along roadsides. Other correlations indicated that plants with good initial growth had good seed germination, giving a new method of selecting for improved seed germination.

For each of the 3 experimental plantings a list of visually selected plants, arranged from most uniform (apomictic) to most variable (sexual), is given. These lists show the variation available in the plant material which is predominantly from the sexual parent 16B.

SELECTION OF *POA PRATENSIS* L. (KENTUCKY BLUEGRASS)

Introduction

The purpose of this project was to select Kentucky bluegrass types whose characteristics would meet the necessary requirements of a roadside turf. The requirements considered most important were increased rhizome spread for quick establishment and long-term maintenance of sloping areas, low growth habit in order to reduce mowing frequency, plus resistance to disease.

The following example illustrates the importance of one of these characters. There are 600 miles of interstate highway system in Indiana, with 18 acres per linear mile, giving a total of 11,000 acres which need to be mowed 4 cycles each year. At a mowing cost of $10.00 per acre, the importance of low growth habit is obvious. In addition to financial considerations, the esthetic and labor-saving value of dwarfness is apparent for home lawns and other turfgrass areas.

The Kentucky bluegrass selection program at Purdue University began in 1961, developing into a roadside project in 1965. This project was undertaken with the knowledge that a superior turfgrass would need only to out-perform the combination of native Kentucky bluegrass and tall fescue, and be propagated by seed. This report is a detailed description of the process and results of this effort to develop that grass.

Since the sexual bluegrass selection 16B produces many plant types, wide variation was available. In 1963 over 100 distinct bluegrass types were selected from the progeny of this single plant. Since selection for variation has been necessary, the sexual progeny of the 16B plant material has predominated in the successive selection program for the last four generations with new germ plasm brought in through pollen of other bluegrass selections from universities, industrial groups, and also other countries. Because of the possibility of genotype-environment interaction, it is believed this wide genetic base will be important when the plants judged superior under ideal research conditions will be tested under the less ideal roadside conditions.

Since the initiation of the roadside program, over 12,000 individual bluegrass seedlings have been rated and observed as spaced plants for leaf color, winter survival, and panicle characteristics, as well as the more important characteristics mentioned earlier.

Review of Literature

The ultimate proof of a breeding method is its value in the breeding of improved varieties. In Kentucky bluegrass, a species known for its problems with apomixis, methods must be used which circumvent this breeding problem, and if possible, use it to advantage. Berry (4) in a 1965 thesis found that broad sense heritability estimates for Kentucky bluegrass were high, ranging from .84 to .98, indicating that the selection for desired genotypes within a population would be relatively efficient. Calculation of expected genetic advance in percent of the mean indicated that progress could be expected through selection. The expected amount of genetic advance for rhizome spread was 59%.

Smith (15) points out the necessity for understanding the mode of reproduction and seed formation of a species. This is especially important in an apomictic species. Åkerberg (1) in 1939 first described somatic apospory as the mechanism of apomixis in Kentucky bluegrass. The cell that functions as the embryo sac is formed from non-archesporial tissue in the nucellus, therefore developing directly without a meiotic division. Thus an unreduced egg is produced parthenogenetically, giving rise, through seed, to a plant genetically identical to the mother plant even though this plant is highly heterozygous. Åkerberg (3) in 1943 demonstrated that pollination with fertilization of the polar nuclei (pseudogamy) is necessary for endosperm and subsequent seed formation. Tinney (17), Åkerberg (2), Nielsen (13), and Grazi, et.al. (9) have indicated that Kentucky bluegrass plants can range from highly sexual where a megaspore results from meiotic divisions, to highly apomictic where the meiotically produced megaspore degenerates and aposporous embryo sacs are produced. Plants intermediate between sexual and apomictic may produce both reduced (meiotic) and unreduced (aposporous) egg cells.

Gardner (8) states that sexual plants are necessary in the development of new and improved strains in a breeding program, almost a contradiction in an apomictic species. There is, however, much evidence that Kentucky bluegrass, though mainly apomictic, produces some aberrant plants through sexual reproduction. With certain limitations the percent of aberrant plants in the progeny has been used as a measure of sexual reproduction. Åkerberg (1) in 1939 found 5.9 to 13.4% sexual plants in selected families. Seven of the 44 families he used showed wide variation. Again in 1942 he (2) found that 3.9% of 79 families of 5 plants each were aberrant, and in 9 cases no two plants of the 5 were alike.

Tinney and Aamodt (17) found the percentage of sexual plants ranging from 0 to 21.9%, Brown (6) found from 0.09 to 18.1% in six seed lots, and Brittingham (5) found an average of 14.8% aberrants in 115 progenies, and one selection had a maximum of 90.5% aberrants. Gazi, et.al. (9) in 1961 found that 75.8% of 800 progenies derived from single panicles appeared to have some aberrant types. They reported that the total number of aberrant types in the population was 16.5%, and if only segregating types were studied, the figure became 20.5%. Also, in the 1968 North Eastern Region Turfgrass Report it was mentioned that a selected clone from Alabama (10) was consistently producing off-types, and that environment did not seem to affect the mode of reproduction of this clone.

In a 1963 thesis Melkerson (12), using comparative measurements and observations showed that there was variation within some bluegrass selections, especially 16B. He further stated that 16B was particularly valuable because many of its seedlings were vigorous, therefore offering great possibility for the development of roadside turf.

Besides the availability of sexual plants, another problem is the fixing of the genome through recovery of the apomictic mechanism. Studies by Carnahan and Hill (7), Gerstel and Mischanec (10), and Harlan, et.al.(11) on both faculative and obligate apomictic groups have produced data leading to the possible conclusion that the overall process is genetically controlled, and in most groups is recessive to sexuality. It must be understood, however, that more than one mechanism of apomixis may exist, thus complicating the efficient use of apomixis for seed production.

In 1966 Taliaferro and Bashaw (16) reported the study of obligate apomixis in buffelgrass, Pennisetum ciliare, using both selfed and F_1 progenies. Using a mutant sexual plant as the female parent, the progeny was classified for mode of reproduction using embryo sac analysis or progeny variation. In the S_1 progeny the sexual to apomictic ratio was not significantly different from a 13 : 3, and in the F_1 progeny the sexual to apomictic ratio was not significantly different from a 5 : 3. Using this information they hypothesized a breeding program using obligate apomixis as a means of fixing the genotype in improved varieties. The schematic model for this breeding program is shown in figure 1. The only limitation in this model is the availability of sexual and apomictic plants in the desired species.

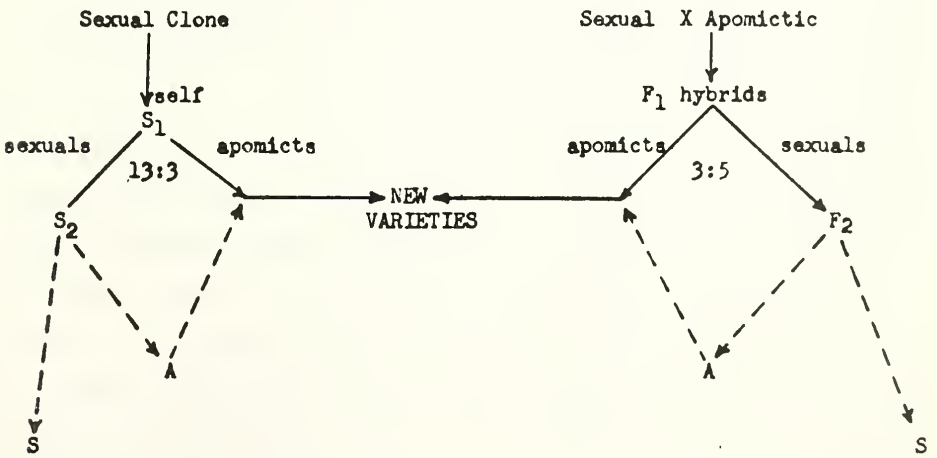

Figure 1. Diagram of methods of developing new apomictic varieties of buffelgrass.

Materials and Methods

Three experimental plantings were made; the first in 1966, the second in 1967, and the third, which was a second generation planting from experiments 1 and 2, in 1969. Seventy-five percent of the seedlings in each of the three experiments were derived from the original sexual plant 16B, while the remainder of the material was from other commercial and experimental sources.

Individual seedlings for the three experiments were grown in 10x10 cm. pots in the greenhouse over winter and then transplanted into the field each spring.

For each experiment more closely related genetic materials, based on female parent, were grown together. In experiments 1 and 2, 15 plants 60 cm. apart were planted in rows 75 cm. apart. In experiment 3, 38 plants of each genetic source and the female parent were grown in a 1.2 x 4.5 plot.

Experiment 1, consisting of 150 selections of 15 plants each (total spaced plants 2250), was measured four times for plant leaf height, three times for rhizome spread, and plant panicle height. These plants were also rated for leaf color, rust resistance (Puccinia graminis), winter survival, and panicle quantity and maturity. In all cases where ratings were made the range was 1 best to 9 least desired, with 1 being most rhizome spread, darkest leaf color, best rust resistance, best winter survival, largest panicle quantity, and earliest panicle maturity. Further information on procedures for measurements and ratings is available.[1]

[1]Riordan, T.P., 1968. "Improvement of Poa pratensis L. through breeding and selection", M.S. Thesis. Purdue University.

Experiment 2, consisting of 200 selections of 15 plants each (total spaced plants 3000) was measured for leaf height, rhizome spread, and panicle height. Ratings from 1 to 9 were taken for leaf color, panicle quantity, and panicle maturity.

Experiment 3, consisting of 60 selections of 39 plants each (total spaced plants 2340), was measured for leaf height and rhizome spread. Ratings were also made for leaf color and rust resistance. Seed lot tests were made to give ratings on germination and measurements of the average seedling height, the number of leaves per 10 seedlings, and the number of tillers per 10 seedlings. After a summer growing season each plot (an individual selection) was rated for uniformity of the plot, percent plants like the female parent, and percent distinct kinds of off-types.

Based on ratings, measurements and visual judgment, seed was harvested from selected space plants in experiments 1 and 2 to give materials for the next generation planting, experiment 3. Using all available information from two generations, selections were made from experiment 3. Vegetative material was taken from these selected plants to provide plants for further selection and roadside testing.

Selected plants were ranked from those appearing most uniform (apomictic) to those appearing most variable (sexual). In experiment 1 and 2 this was accomplished by ranking the average coefficient of variation for the characters measured and rated, with the least average coefficient of variation being the plants appearing apomictic. In the third experiment selected plants were ranked according to uniformity data taken, most uniform considered most apomictic.

Results and Discussion

Experiment 1 (planted 1966) was the second planting made with the goal of developing a roadside grass. Past experience had given some idea of the characters that should be measured and the time of measurement. A list of characters studied and the date these measurements or ratings were taken is given in Table 1.

Since no replications of individual plants were made, tests for superiority of individuals were not made. In order to give some indication of the value of data taken and plants selected, means and standard deviations of characters of the total population, of selected families (only families which included selected plants), and of the selected plants within families were calculated. These are also given in Table 1.

From the means of rhizome spread data, the most important character measured, it is seen that rhizome spread has increased going from the total population to selected families to selected plants, and that the greatest change was from selected families to selected plants. These changes cannot be considered improvement, since heritability is not 1.0. Berry's (4) high estimates for heritability (.84 to .98) in Poa pratensis only indicate that improvement is possible.

The means of leaf height show a very slight increase in leaf length. This is inconsistent with the goal that selection was being made for low growth. This result may be understood by past field observations showing that the characters rhizome spread and leaf height were negatively correlated, and that during visual selection more emphasis had been put on rhizome spread. Thus, for the selected plants, increase was found in the character rhizome spread without change in leaf height.

Table 1. Means and standard deviations for total population, selected families, and selected plants for characteristics (listed in order of importance) of experiment 1.

Character		Date	Total pop. (2250 plants) Mean	Std.dev.	Sel. families (435 plants) Mean	Std.dev.	Sel. plants (31 plants) Mean	Std.dev.
Rhizome spread*								
1	I	8/15/66	5.7	1.2	5.4	1.3	4.8	1.5
2	II	12/19/66	5.1	1.7	4.6	1.8	3.3	1.7
3	III	7/15/66	4.5	1.5	3.9	1.5	2.5	1.2
Leaf height (cm.)								
4	I	8/15/66	13.	4.3	14.	4.5	14.	4.7
5	II	10/1/66	17.	5.6	18.	5.3	18.	5.3
6	III	4/15/67	17.	6.4	19.	8.4	21.	6.2
7	IV	8/15/67	11.	4.0	11.	3.8	11.	4.1
Rust resistance*								
8		10/15/66	5.6	1.6	5.4	1.7	5.2	1.9
Leaf color*								
9		8/16/66	4.3	1.1	4.2	1.1	4.3	1.2
Winter survival*								
10		4/8/67	2.4	2.3	2.1	2.1	1.4	1.8
Panicle height (cm.)								
11		6/15/67	53.	30.	55.	27.	60.	15.
Panicle quantity*								
12		6/14/67	4.7	1.8	4.2	1.9	3.3	1.4
Panicle maturity*								
13		6/6/67	4.7	1.4	4.7	1.3	4.4	1.1

*Rating 1 - 9, 1 best

There was slight increase in the important character of rust resistance, but at this stage in selection, the lack of resistance has been accepted, if it was on an otherwise superior plant. This character was measured so that individuals with good rust resistance could be closely observed in future tests. Selected plants had better winter survival, but usually a superior plant has no winter survival problem; thus the character is considered of limited importance. Leaf color indicated that superior plants could be light green to dark green.

The seedhead characteristics did not change much in the three plant groups, but these data were taken only as an aid to future seed production, so the characters were considered of less importance in the selection of superior plants.

Simple correlation coefficients among characteristics of experiment 1 are listed in Table 2. They are given for the total population, the selected families, and the selected plants; significance is given only for the selected plants (df=31). The highly significant simple correlation coefficients for the multiple measurements of rhizome spread and also for the multiple measurements of leaf height are shown, but the lack of higher correlations indicates the possibility of error since no replicates were available in the spaced plantings. It can be seen that the three measurements of rhizome spread are highly negatively correlated with the four leaf height measurements. These correlations validate the poor results on the reduction in leaf height when visual emphasis is on rhizome spread. Leaf height IV seems to be out of line with the other correlations, and it is thought that this is due to collection of data in the middle of the summer (July 15) of the second year.

Table 2. Simple correlation coefficients for total population, selected families, and selected plants for the characteristics of experiment 1.

	1	2	3	4	5	6	7	8	9	10	11	12	13
	Rhizome spread			Leaf height				Rust	Leaf	Wint.		Panicle	
	I	II	III	I	II	III	IV	res.	col.	sur.	ht.	quan.	mat.
		.77	.61	-.57	-.58	-.50	-.25	-.05	.26	-.02	-.43	.48	.16
1	1.0	.80	.67	-.57	-.57	-.46	-.24	.10	.40	.09	-.48	.54	.26
		.70	.64	-.48	-.63	-.51	-.11	-.20	.58	-.06	-.30	.49	.06
		**	**	**	**	**			**			**	
			.75	-.48	-.53	-.54	-.30	.08	.22	.14	-.52	.60	.22
2		1.0	.79	-.51	-.58	-.42	-.28	.19	.32	.21	-.58	.64	.32
			.60	-.32	-.54	-.36	.02	-.12	.51	.08	-.28	.49	.15
			**		**	*			**			**	
				-.34	-.39	-.42	-.35	.05	.18	.15	-.58	.57	.20
3			1.0	-.37	-.44	-.36	-.29	.13	.27	.19	-.60	.58	.23
				-.03	-.42	-.31	-.12	-.16	.20	.02	-.19	.32	-.15
					*								
					.78	.56	.42	.05	-.10	.15	.41	-.31	-.18
4				1.0	.75	.53	.42	-.13	-.16	-.13	.47	-.44	-.29
					.76	.53	.30	.05	-.41	-.08	.16	-.25	-.07
					**	**			*				
						.60	.48	.09	-.10	.18	.43	-.31	-.17
5					1.0	.56	.42	.04	-.21	-.11	.48	-.48	-.26
						.62	.23	.27	-.52	.00	.24	-.38	.12
						**			**			*	
							.36	-.18	-.14	-.16	.48	-.47	-.24
6						1.0	.30	-.18	-.15	-.13	.33	-.43	-.28
							.34	-.18	-.01	-.34	.32	-.50	-.15
							*			*		**	
								-.04	.06	.02	.37	-.24	-.21
7							1.0	-.12	-.13	-.10	.34	-.27	-.18
								-.17	.00	.18	.16	-.05	-.36
													*
									.00	.24	-.01	.01	.14
8								1.0	.06	.25	-.06	.13	.31
									-.12	.14	.11	-.14	.40
													*
										.08	-.16	.19	.00
9									1.0	.12	-.15	.16	.12
										-.35	.08	-.12	.10
										*			
											-.17	.37	.17
10										1.0	-.26	.50	.26
											.06	.21	-.04

Table 2. (Continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13
	Rhizome spread			Leaf height				Rust	Leaf	Wint.	Panicle		
	I	II	III	I	II	III	IV	res.	col.	sur.	ht.	quan.	mat.
												-.56	-.32
11											1.0	-.65	-.35
												-.52	-.32
												**	
													.38
12												1.0	.43
													.12
13													1.0

*Significant at the .05 level.
**Significant at the .01 level.

Other significant correlations seem to be related to the character panicle quantity. These correlations indicate that the more rhizome spread and the higher the leaf height, the greater the panicle quantity; thus seed yield may possibly be maintained in a low-growing plant if the rhizome spread is increased.

Table 3 indicates the plants visually selected in this experiment and the data for each. The variation between plants can be seen, and the possibility of selecting a low-growing, rapidly spreading plant may be envisioned. This table will serve as a reference later when a study of mode of reproduction is made.

The characters and the date of measurement for experiment 2 are shown in Table 4 along with means and standard deviations of these characters. Again as in experiment 1 there is increase in rhizome spread going from the total population to selected families and to selected plants. Also there is little change in leaf height. The means for leaf color and the panicle characters likewise give results comparable to that of experiment 1.

The simple correlation coefficients are given in Table 5 for the three plant groups and significance is indicated for the selected plants (df=14). Generally correlations are similar to those of experiment 1, but the significant correlations are reduced due to the smaller number of selected plants. The highly significant correlation between the character leaf height and panicle height gives promise of reduced panicle height by reducing leaf height. A highly negative correlation is shown for the characters panicle height and panicle maturity, which is expected since many common bluegrass types tend to mature early while turf types tend to mature later, according to field observations.

Table 3. Selected plants and data for experiment 1, organized from most uniform (appearing apomictic) to most variable (appearing sexual).

Selection			Rhizome spread*			Leaf height(cm.)				Rust res. *	Leaf col. *	Wint. sur. *	Panicle ht. (cm.)	Panicle quan. *	Panicle mat. *	
Parent	Seedling		I	II	III	I	II	III	IV							
1	16B1	60-29	3	3	2	18	18	25	12	1	2	1	58	4	4	Uni-
2	16B9	8-12	5	4	3	20	20	20	15	6	5	1	72	1	5	form
3	K547		5	4	4	15	20	20	15	5	4	1	48	4	4	
4	A10	60-32	5	3	2	15	18	22	12	5	4	1	58	4	5	
5	16F	1-2	4	3	2	12	18	28	8	7	4	1	65	1	6	
6	16B19	20-4	5	4	3	12	20	20	8	7	4	1	50	4	7	
7	16B167	11-23	3	3	2	20	28	32	15	5	4	1	65	3	5	
8	A10	20-34	5	4	2	15	18	20	10	6	4	1	65	4	5	
9	16B	23-19	5	2	2	15	15	18	8	3	5	1	55	3	3	
10	16B9	8-12	3	1	2	22	25	32	22	2	4	1	62	2	3	
11	16B18	55-24	7	5	3	5	12	18	12	3	5	1	60	6	5	
12	16B18	55-24	8	7	4	8	8	8	10	6	5	1	45	6	6	
13	16B6	31-15	3	1	2	12	15	12	10	4	5	1	65	1	4	
14	16B34	31-24	7	5	5	22	22	20	12	6	5	3	58	4	4	
15	A10	30-2	4	4	2	15	22	25	8	6	4	1	62	4	4	
16	16B9	34-18	3	3	1	12	22	20	20	7	3	6	60	3	4	
17	16B34	43-14	6	3	4	14	18	8	8	5	4	1	58	3	5	
18	16B18	11-16	4	3	3	18	12	12	8	6	4	1	62	3	4	
19	16B9	50-31	4	2	2	18	20	18	8	7	2	5	68	3	5	
20	16B9	19-28	5	2	2	8	18	15	8	5	5	1	65	1	4	
21	16B1	30-14	4	2	2	15	22	28	12	7	5	1	60	2	5	
22	16B1	30-14	3	5	1	15	22	25	10	7	5	1	65	2	4	
23	16B9	38-18	5	3	3	12	18	18	8	2	4	5	55	5	5	
24	16B9	48-31	3	1	1	12	15	12	8	9	5	2	60	4	5	
25	A10	48-34	5	2	1	10	18	12	10	5	3	7	60	4	5	
26	A10	47-21	4	1	1	15	25	28	10	6	4	1	62	4	5	
27	Piq.6	30-19	4	5	4	20	18	15	10	6	3	4	55	4	5	
28	16B1	23-14	5	2	2	15	22	25	10	5	4	1	60	1	4	
29	16B	37-7	5	4	4	12	18	18	10	2	4	1	65	4	2	
30	A10	20-34	6	3	2	15	25	25	10	6	4	1	60	4	3	Vari-
31	16B29	59-15	6	4	5	8	18	18	20	6	5	5	68	4	2	able
Range		Best	3	1	1	5	8	8	8	1	2	1	45	1	2	
		Worst	8	5	5	22	25	32	22	9	5	7	72	6	5	

*Rating 1-9, 1 best

Table 4. Means and standard deviations for total population, selected families, and selected plants for characteristics (listed in order of importance) of experiment 2.

Character	Date	Total pop. (3000 plants) Mean	Std.dev.	Sel. families (225 plants) Mean	Std.dev.	Sel. plants (15 plants) Mean	Std.dev.
Rhizome spread* 1	8/27/68	4.9	1.7	4.9	1.8	3.3	1.0
Leaf height (cm.) 2	5/20/68	24.	16.	23.	8.5	24.	8.4
Leaf color* 3	6/10/68	4.1	1.2	4.6	4.0	3.9	1.4
Panicle height (cm.) 4	6/18/68	58.	46.	58.	23.	61.	15.
Panicle quantity* 5	6/5/68	5.5	2.4	6.2	4.1	4.3	1.6
Panicle maturity* 6	6/13/68	5.7	1.4	6.2	1.2	6.1	0.9

*Rating 1 - 9, 1 best

Table 5. Simple correlation coefficients for total population, selected families, and selected plants for the characteristics of experiment 2.

	Rhizome spread 1	Leaf Height 2	Leaf Color 3	Panicle Height 4	Panicle Quantity 5	Panicle Maturity 6
		-.57	.26	-.58	.69	.22
1	1.0	-.23	.17	-.04	.27	.05
		-.22	.27	.29	.12	-.02
			-.06	.93	.20	-.31
2		1.0	-.06	.54	-.24	-.52
			.36	.88	-.30	-.53
				**		*
				-.13	.21	-.10
3			1.0	.64	.91	.01
				.33	.40	-.11
					.40	-.27
4				1.0	.50	-.53
					.26	-.74
						**
						.46
5					1.0	.49
						.49
						*
6						1.0

*Significant at the .05 level.
**Significant at the .01 level.

In Table 6 the variation between plants can be noted, and the possibility of selected plants with certain characteristics may be visualized. References to this table will be made later when mode of reproduction is studied.

The characters and date of measurement of experiment 3 and the means and standard deviations for these characters are shown in Table 7. As in the previous experiments an increase in rhizome spread is indicated, but in this case there is a decrease of 1.1 cm. in average leaf height. This has probably been an effect of this experiment's being the second generation of selection. The 3 new characters measured (2-3-5) show some difference with a slight increase in the number of leaves and number of tillers per 10 plants, and also a slightly greater seedling height.

The characters rust resistance and leaf color show slight change, since little emphasis was put on them when plants were visually selected. Rust resistance was measured during a very pronounced infestation, and nearly all families showed only slight resistance. The character seed germination showed no change in the 3 groups, indicating that selected plants were no better or worse than the population as far as this character was concerned. This in itself is promising since the character is important and possibly selection of individuals could be used to improve germination. The final 3 characteristics are tests of variability. The rating for uniformity (1 - uniform, 9 - variable) and the percent distinct offtypes increased, while the percent of plants like the female parent decreased, showing the effect of selection for variable plants.

The simple correlations for the characteristics of the 3 groups of experiment 3 are given in Table 8 (df=61). The correlations are again similar, but with the added information of the new data.

Table 6. Selected plants and data for experiment 2, organized from most uniform (appearing apomictic) to most variable (appearing sexual).

	Selection		Rhizome spread *	Leaf height (cm.)	Leaf color *	Panicle ht. (cm.)	Panicle quant. *	Panicle mat. *	
	Parent	Seedling							
1	16BB18	80-14	2	18	2	60	4	6	Uniform
2	16B18	95-22	4	25	5	70	2	5	
3	Bower	23-19	4	22	4	50	6	8	
4	16BB86	13-25	5	38	5	78	5	6	
5	16H	50-1	3	32	6	82	6	5	
6	K547	50-26	3	20	2	52	4	6	
7	16BB106	90-10	2	28	2	62	3	6	
8	16B84	90-24	5	20	3	68	5	6	
9	16H	19-18	2	32	5	75	4	5	
10	16B72	19-10	3	12	2	40	4	6	
11	16B	37-7	4	22	5	58	6	6	
12	16B30	21-8	3	35	4	75	4	6	
13	16BB76	87-3	3	30	3	60	1	6	
14	16B25	50-9	4	25	5	62	4	6	
15	16B8	24-3	2	8	5	25	7	8	Variable
	Range	Best	2	8	2	25	1	5	
		Worst	5	38	6	82	6	8	

*Rating 1-9, 1 best

Table 7. Means and standard deviations for total population, selected families, and selected plants for characteristics (listed in order of importance) of experiment 3.

Character	Date	Total pop. (2400 plants) Mean	Std.dev.	Sel. families (1520 plants) Mean	Std.dev.	Sel.plants (59 plants) Mean	Std.dev.
Rhizome spread* 1	10/15/69	4.2	1.5	4.0	1.4	3.4	1.6
No.of tillers/ 10 plants 2	11/68	8.1	6.3	8.1	6.6	9.4	7.9
No.of leaves/ 10 plants 3	11/68	52.	13.	52.	13.	56.	18.
Leaf height (cm.) 4	8/20/69	12.	4.2	12.	4.2	11.	3.8
Seedling height (cm.) 5	11/68	4.7	0.9	4.8	0.9	4.7	0.9
Rust resistance* 6	9/20/69	5.8	1.6	5.7	1.7	5.5	1.5
Leaf color* 7	10/1/69	3.8	1.0	3.7	0.9	3.5	1.0
Seed germination* 8	8/15/69	7.2	1.8	7.2	1.8	7.2	1.8
Rating of uniformity* 9	10/69	3.8	2.9	4.0	3.0	5.0	3.1
% plants like female parent 10	10/69	70.	35.	68.	37.	54.	37.
% distinct offtypes 11	10/69	23.	25.	24.	25.	26.	24.

*Rating 1 - 9, 1 best

Table 8. Simple correlation coefficients for total population, selected families, and selected plants for the characteristics of experiment 3.

	1	2	3	4	5	6	7	8	9	10	11
	Rhizome spread	No. of tillers / 10 plants	No. of leaves / 10 plants	Leaf height (cm.)	Seedling height (cm.)	Rust resistance	Leaf color	Seedling germination	Rating of uniformity	No. plants like female parent	No. distinct offtypes
		-.02	-.04	-.36	-.18	.25	.03	.08	.32	-.31	.12
1	1.0	.10	.02	-.36	-.04	.21	.20	.09	.31	-.34	.13
		-.06	-.11	-.11	-.13	.14	.40**	.00	.00	-.05	.34*
			.82	.10	-.20	-.02	-.13	.35	-.01	.03	.28
2		1.0	.83	-.01	-.35	-.08	-.15	.45	.00	.00	.47
			.93**	-.25	-.40**	.00	-.22	.54**	.20	-.17	.57**
				.10	-.28	-.15	-.12	.39	.02	.01	.12
3			1.0	.03	-.36	-.27	-.10	.48	.04	-.02	.24
				-.19	-.39**	-.15	-.14	.57**	.27*	.22	.48**
					-.01	-.19	-.21	-.02	-.42	.48	-.14
4				1.0	-.15	-.28	-.22	.03	-.40	.52	-.05
					-.28*	-.17	-.13	-.12	-.63**	.71**	-.19
						.08	.26	-.25	.21	-.28	.12
5					1.0	.17	.29	-.15	.41	-.47	.26
						.09	.32*	-.27*	.36**	-.44**	-.06
							.09	-.09	.17	-.14	.00
6						1.0	.22	-.06	.19	-.17	.08
							.10	-.06	.11	-.12	.41**
								-.04	.15	-.25	.17
7							1.0	-.02	.09	-.23	.19
								-.04	-.06	-.10	.24
									.00	-.01	.21
8								1.0	-.01	.02	.11
									.03	.00	.29*

Table 8. (Continued)

1	2	3	4	5	6	7	8	9	10	11
	Rhizome spread	No. of tillers / 10 plants	No. of leaves / 10 plants	Leaf height (cm.)	Seedling height (cm.)	Rust resistance	Leaf color	Seedling germination	Rating of uniformity	No. plants like female parent	No. distinct offtypes
9									1.0	-.95 -.94 -.93 **	.46 .54 .45 **
10										1.0	-.52 -.42 -.39 **
11											1.0

*Significant at the .05 level.
**Significant at the .01 level.

The number of leaves per 10 plants and number of tillers per 10 plants are highly positively correlated, and they are both positively correlated with seed germination; a plant that produces a lot of early vegetative growth has good seed germination or vice versa. Seedling height was measured as a prediction of leaf height, but these measurements show a negative correlation, evidently reducing the effectiveness of early prediction. The three tests of uniformity show significant correlations, adding value to these measurements.

The visually selected plants and their data are given in Table 9. These plants will be used in roadside planting and in future selection work.

Tables 3, 6, and 9 are lists of the selected plants for the two preliminary selection experiments and the second generation selection experiment respectively. These three lists are arranged in order from the plant appearing most apomictic to the plant appearing most sexual. In Table 9 the last column contains the rank in average coefficient of variation of the previous generation. (1-28; experiment one, plant 28 - appearing variable). Some plants do not have this information because they were not tested in a previous generation. The normal trend is that uniform plants beget uniform, and sexual beget sexual, but with certain exceptions such as selections 1-4, the 16B-1 material. This information possibly will allow superior uniform plants of two generations to be moved directly into roadside tests due to the possible apomictic character, while variable plants are used for further testing and selection.

Table 9. Selected plants and data for experiment 3, organized from most uniform to most variable.

1. Rhizome spread*[1]
2. No. of tillers / 10 plants
3. No. of leaves / 10 plants
4. Leaf height (cm.)
5. Seedling height (cm.)
6. Rust resistance*
7. Leaf color*
8. Seedling germination *
9. Rating of uniformity*
10. No. of plants like female parent
11. No. of distinct offtypes
12. Rank of average C.V. in first generation

	Selection: Parent	Seedling	1	2	3	4	5	6	7	8	9	10	11	12
1	16B1	23-14	3	4	41	12	3.7	2	2	3	1	39	0	1-28
2	16B1	23-14	3	4	36	15	4.0	9	4	5	1	39	0	1-28
3	16B1	30-14	3	2	39	18	4.8	8	4	4	1	39	0	1-21
4	16B1	30-14	3	3	38	15	4.0	8	4	4	1	39	0	1-22
5	16B1	60-29	4	5	53	27	5.2	3	3	6	1	39	0	1-1
6	16B6	31-15	3	5	46	15	5.0	8	4	9	1	39	0	1-6
7	16B9	8-12	3	9	58	16	4.7	2	3	8	1	39	0	1-2
8	16B9	8-12	3	8	65	14	4.2	2	3	9	1	39	0	1-10
9	16BB10	50-14	4	23	76	14	3.0	3	3	9	1	39	0	2-1
10	16B18	95-22	4	14	59	10	3.9	6	3	9	1	39	0	2-2
11	K547	50-26	4	29	82	12	3.6	6	3	9	1	39	0	2-6
12	16B36	93-10	3	5	66	16	4.0	2	5	8	1	39	0	—
13	16BB76	87-3	3	7	48	12	5.2	7	2	9	1	39	0	2-13
14	16BB106	90-10	5	8	43	10	3.7	6	4	9	1	39	0	2-7
15	A10	30-2	4	13	65	11	5.0	5	4	5	1	39	0	1-15
16	K547	43-25	3	3	48	18	3.8	8	5	8	1	39	0	—
17	16B29	59-15	4	1	44	15	3.7	3	3	3	2	37	1	1-31
18	16B18	55-24	3	13	43	12	6.9	7	4	7	2	37	2	1-12
19	Athens	69-1	4	8	53	11	4.7	7	5	7	2	37	2	—
20	16B9	38-18	4	5	37	11	4.4	8	3	8	2	36	2	1-23
21	16BB5/x21	46-27	4	10	58	17	4.7	5	4	9	2	35	3	—
22	WSLD	1-2	2	1	43	10	5.4	5	3	9	3	30	4	—
23	16B9	38-18	8	12	57	11	3.5	9	2	9	3	30	5	1-16
24	16BB86	13-25	3	1	40	13	5.4	6	3	6	4	20	5	2-4
25	16B24xB171	104-28	4	6	50	9	5.8	9	5	9	4	12	4	—

Table 9. (Continued)

Selection													
	Parent	Seedling	1	2	3	4	5	6	7	8	9	10	11	12
26	16B24xB171	104-28	3	6	50	9	5.8	9	5	9	4	12	5	—
27	16B9	50-31	1	9	49	13	4.4	7	2	7	5	20	7	1-19
28	16BB172	74-13	3	10	55	10	5.6	6	4	6	5	6	6	—
29	16BB172	74-13	5	10	55	7	5.6	6	5	6	5	6	6	—
30	16BB172	74-13	4	10	55	6	5.6	6	4	6	5	6	6	—
31	16B8	24-3	1	—	—	12	—	6	2	9	6	25	5	2-15
32	16B9	19-28	6	3	56	16	4.5	6	3	8	6	25	8	1-20
33	16B30	21-8	1	2	41	12	5.4	6	3	6	6	20	8	2-12
34	16B30	21-8	2	2	41	12	5.4	6	3	6	6	20	8	2-12
35	16B30	21-8	3	2	41	12	5.4	6	2	6	6	20	8	2-12
36	16B34	43-14	3	5	37	11	5.7	7	2	5	7	15	8	1-17
37	16B34	43-14	2	5	37	10	5.7	7	2	5	7	15	8	1-17
38	16B34	43-14	4	5	37	7	5.7	7	3	5	7	15	8	1-17
39	16B72	19-10	4	2	40	7	5.9	7	4	8	7	10	10	2-10
40	Bower	23-19	4	13	55	6	4.3	7	4	9	7	5	4	2-3
41	16H	19-18	4	6	50	6	5.8	5	4	5	7	4	3	2-9
42	16H	19-18	3	6	50	6	5.8	5	3	5	7	4	3	2-9
43	16B42	11-8	4	27	99	9	4.4	6	3	9	8	10	12	—
44	16B42	11-8	3	27	99	8	4.4	5	3	9	8	10	12	—
45	16B42	11-8	4	27	99	8	4.4	5	3	9	8	10	12	—
46	16B42	11-8	1	27	99	12	4.4	5	3	9	8	10	12	—
47	16B42	11-8	1	27	99	8	4.4	6	3	9	8	10	12	—
48	16B42	11-8	3	27	99	7	4.4	6	3	9	8	10	12	—
49	16B55	86-26	2	11	67	9	4.8	5	3	8	8	10	12	—
50	16B55	86-26	1	11	67	9	4.8	6	3	8	8	10	12	—
51	16B55	86-26	3	8	67	8	4.8	6	4	8	8	10	12	—
52	16B55	86-26	1	7	67	7	4.8	6	3	8	8	10	12	—
53	16B25	50-9	4	8	57	8	4.6	6	3	7	8	8	8	2-14
54	16B25	50-9	2	10	57	10	4.6	6	3	7	8	8	8	2-14
55	16B25	50-9	4	13	57	13	4.6	6	4	7	8	8	8	2-14
56	16B9	48-31	3	14	52	13	5.1	5	2	6	9	10	15	1-24
57	16H	54-1	3	1	41	10	7.2	5	5	6	9	7	5	—
58	16H	54-1	4	1	41	8	7.2	5	5	6	9	7	5	—
59	Piqua	30-19	6	4	45	7	4.4	5	4	7	9	6	4	1-27
Range		Best	1	29	99	27	7.2	2	2	3	1	4	0	
		Worst	8	1	36	6	3.6	9	5	9	9	39	15	

*Rating 1 - 9, 1 best

[1](Rating 1, spread 48 cm. or more; rating 9, spread 12 cm. or less)

Summary and Conclusions

Over 12,000 individual Kentucky bluegrass seedlings were rated and measured with the goal of selection of types adaptable to roadside utilization. Two preliminary experimental plantings and a later third planting, which included mainly the selected plant material from the first generation experiments, were made.

All plants were rated for rhizome spread and measured for leaf height. In addition to these more important characteristics, other ratings and measurements were made in each experiment. In experiment 1 rust resistance, leaf color, winter survival, and the panicle characteristics; in experiment 2 leaf color and panicle characteristics; and in experiment 3 rust resistance, leaf color, seed germination, and seedling characteristics were rated or measured. In experiment 3 selections consisting of 38 spaced plants and the parent clone were rated and measured for uniformity.

Selection done in each experiment was based predominantly on visual observation. Means and standard deviations of selected plants were compared to those of selected families and the total population. In each experiment there was an increase in the amount of rhizome spread among the selected plants with little, if any, increase in leaf height. This is considered acceptable due to the significant negative correlation which was later calculated for the two characters. In experiment 3, the second generation of selection, there was a slight decrease in leaf height, giving promise for future decrease in this character.

Simple correlation coefficients were calculated for all characters in each experiment. In addition to the significant negative correlation

found between leaf height and rhizome spread, panicle height was generally positively correlated with leaf height and negatively correlated with rhizome spread. This indicates that if leaf height is reduced in future generations of selection, it may be possible to have lower, more acceptable panicle heights along roadsides. In experiment 3 the significant simple correlation coefficients of the seedling characteristics showed that plants with increased initial growth (leaves and tillers) also had good seed germination or vice versa. These characteristics are considered important for roadside establishment. The positive relationship gives promise that selection of plants which had good initial growth would also have good seed germination. The negative correlation of seedling height and leaf height indicated that the early measurement is not a good prediction of leaf height. Other tests of this relationship should be made since early prediction of leaf height would be valuable.

For each experiment the visually selected plants are listed. The lists are included to indicate the variability available within the 16B plant material for future hybridization. These lists of selected plants were each organized from the most uniform plant to the most variable plant. It is believed that uniform plants, due to the possible apomictic mode of reproduction, are ready for roadside testing and plant increase (both vegetative and seed), while variable plants, due to the possible sexual mode of reproduction, are considered part of the selection program.

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